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EFFECTIVENESS OF INSTRUCTION BY TELEVISION IN TEACHING HIGH SCHOOL CHEMISTRY IN ALABAMA SCHOOLS.

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THIS STUDY ATTEMPTED TO PROVIDE DEFINITIVE ANSWERS TO THE QUESTION OF THE EFFECTIVENESS OF TELEVISION INSTRUCTION IN HIGH SCHOOL CHEMISTRY UNDER VARIED CONDITIONS. THE SAMPLE OBTAINED INCLUDED PREDOMINANTLY WHITE AND NEGRO SCHOOLS USING TELEVISION (FOUR OF EACH), AND PREDOMINANTLY WHITE AND NEGRO SCHOOLS NOT USING TELEVISION (SIX AND ONE). GROSS QUALITATIVE JUDGMENTS OF THE (1) ADEQUACY OF LABORATORY FACILITIES, (2) QUALITY OF TEACHERS, AND (3) MENTAL ABILITY OF STUDENTS WERE USED AS CONTROLS. EFFECTIVENESS OF TELEVISION TEACHING WAS MEASURED BY A COMPARISON OF STUDENT GRADES ON A STANDARDIZED CHEMISTRY TEST GIVEN IN BOTH THE TELEVISION AND NONTELEVISION SCHOOLS. WHILE SIGNIFICANT DIFFERENCES WERE NOTED, THE RESULTANT DATA PROVED INCONCLUSIVE, PROBABLY BECAUSE OF (1) THE INADEQUACY OF THE SAMPLE SIZE, (2) THE INABILITY TO OBTAIN ADEQUATE CONTROLS, AND (3) THE GROSS MEASURES USED IN THE VARIABLES. IT WAS SUGGESTED THAT IN FUTURE STUDIES STEPS SHOULD BE TAKEN TO INSURE CONTROL OF THE TELEVISION USERS SO PERFORMANCE DIFFERENCES CAN BE ASSIGNED TO THE SPECIFIC INFLUENCE OF TELEVISION OR TO OTHER FACTORS. (PM)

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Effectiveness Of

INSTRUCTION *by* TELEVISION

In Teaching

HIGH SCHOOL CHEMISTRY

In Alabama Schools

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EFFECTIVENESS OF INSTRUCTION BY TELEVISION IN TEACHING HIGH SCHOOL CHEMISTRY IN ALABAMA SCHOOLS

A Pilot Study Designed to Determine the Effectiveness of Instruction by Television Under Varied Conditions in Schools of Alabama

Conducted by the University of Alabama

The research reported herein was supported by a grant from the United States Office of Education, Department of Health, Education, and Welfare.

August 1961

HIGH SCHOOL CHEMISTRY

Produced by the University of Alabama Broadcasting Services
on
The Alabama Educational Television Network
WAIQ, WBIQ, and WCIQ

September 1959 - May 1960

Instructors for the television course:

Dean Robert D. Brown and Professor George M. Toffel
School of Chemistry, University of Alabama
Research Supervisor, Professor Toffel
Research Associate, Mr. T. E. Lundy

INTRODUCTION

Concern has been expressed during the past several years regarding the effectiveness of chemistry teaching in the high school environment. Inadequate laboratory facilities, teachers without proper training, and shortage of funds represent some of the factors frequently cited as disturbing. The Alabama Educational Television Network, through the facilities of the University of Alabama Broadcasting Services and the School of Chemistry, has offered "in-school" chemistry lessons for the past several years in an effort to supplement the high school courses. The network carried the "Continental Classroom" as well as special chemistry programs prepared at the University. The latter included late afternoon enrichment series for high school chemistry teachers and students and a series of lessons presented during summer and holidays entitled "Chemistry Can Be Fun". The large number of high school students and teachers reporting their appreciation for these programs in "feed-back" reports suggested the need for more rigorous testing of the program effectiveness.

Experimentation and research in teaching chemistry by television has been conducted in the Cincinnati and Schenectady public schools and at Purdue University through a closed circuit system. Little or no evaluation has been attempted, however, to determine the relative effectiveness of television instruction under varied conditions of laboratory facilities, teacher training, student ability, and similar factors. The present project, supported by a grant from the United States Office of Education, was designed to provide definitive answers to the question of effectiveness of television instruction under varied conditions in schools throughout the state of Alabama.

PROCEDURES

At the beginning of the 1959-60 academic year, information available in the offices of the University of Alabama Broadcasting Services indicated that seventy-six high schools throughout the state planned to use the television course in supplementing their own instruction in high school chemistry. A sample of these schools representing varied conditions of teacher training, laboratory facilities, student ability, and teaching methods was sought. This sample would be matched with schools having similar conditions but not utilizing educational television. Conditions

beyond control of the investigators prevented obtaining schools to fit the requirements of all cells in the experimental design. For example, when a random sample of those schools reporting use of television instruction was visited, it was found that some had never utilized the facilities. Others had started but dropped out for various reasons, and still others used it occasionally but not consistently.

As a consequence of these difficulties, the design of comparisons between schools as sampling units had to be abandoned. Comparisons were made in terms of individual students as a sampling unit with gross estimates of laboratory facilities, teacher training, and student ability. The resulting sample consisted of four white schools and four Negro schools using television, and six white schools and one Negro school not using television. Table 1 reveals the distribution of students in these schools classified by sex, race, I.Q., adequacy of laboratory facilities, and teacher training.

Examination in Table 1 indicates that only one type of environment in the schools using television was not represented, that of a Negro school with an unqualified teacher and good laboratory facilities. However, several gaps are observed in the schools without television, namely: a white school with qualified teacher and poor laboratory, a Negro school with a qualified teacher and good laboratory, a white school with an unqualified teacher and poor laboratory facilities, a Negro school with an unqualified teacher and poor laboratory, and a Negro school with an unqualified teacher and good laboratory facilities. The absence of cases in these cells seriously hampers the evaluation of results in this study and emphasizes the necessity for better controls in future experimentation in this area. Another difficulty encountered in this study as indicated from Table 1 is the fact that mental ability scores were not available in all schools observed. They were not complete in those schools where some testing had been accomplished. Again, the controls anticipated in this study design were inadequately obtained and the results therefore somewhat inconclusive. In so far as possible statistical controls have been substituted for experimental controls in the interpretation of the data.

The "in-school" series of chemistry lessons for television was planned with the advice of a selected group of high school teachers from various parts of the state. Teaching guides were prepared which contained lesson preparation suggestions, lesson outlines and suggested follow-up procedures. (Study guide for the first semester of the 1959-60 series is attached.) Responsibility for preparing and presenting the chemistry lessons for the first semester was assumed by Dr. Robert D. Brown, Dean of the School of Chemistry at the University of Alabama. The second

TABLE I

DISTRIBUTION OF SAMPLE STUDENTS BY TYPE OF INSTRUCTION, QUALITY OF TEACHER, QUALITY OF LABORATORY, RACE, SEX AND MENTAL ABILITY

	Schools With Television								Schools Without Television							
	White				Negro				White				Negro			
	Male Ability		Female Ability		Male Ability		Female Ability		Male Ability		Female Ability		Male Ability		Female Ability	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Qualified Teacher																
Poor Laboratory.....	8	8	7	11	1	1	0	4	—	—	—	—	0	1	0	11
Good Laboratory.....	29	7	6	0	6	7	1	5	23	1	14	1	—	—	—	—
Unqualified Teacher																
Poor Laboratory.....	9	10	0	8	3	8	2	5	—	—	—	—	—	—	—	—
Good Laboratory.....	12	2	1	5	—	—	—	—	11	7	5	2	—	—	—	—
									5	4	4	2				
									8	7	0	0				
Totals.....	48	27	14	24	14	22	5	26	65	28	36	13	0	1	0	11
Per cent by sex and race.....	64	36	37	64	39	61	16	84	70	30	74	26	0	100	0	100
Per cent High and Low.....	H-55		L-45		H-28		L-72		H-71		L-29		H-0		L-100	

semester lessons were prepared and presented by Associate Professor George M. Toffel of the University School of Chemistry. Each lesson was carefully planned to follow the sequence of subject matter in the state adopted textbook, "Modern Chemistry", by Dull, Brooks, and Metcalfe. Basic facts and principles of chemistry were emphasized throughout and experiments extending the material in the text were presented frequently. The course consisted of three, thirty-minute lessons a week throughout the school year.

The Research Associate, Mr. T. E. Lundy, assumed responsibility for contacting principals and chemistry teachers who agreed to cooperate in the research. He attempted to gather information on the schools, teachers, and students needed for classification purposes and to visit and observe the teaching of chemistry in all cooperating schools at least once during the school year. Information on laboratory facilities was obtained in terms of qualitative judgments of ample, excellent, good, adequate, fair and poor. For analytical purposes classes were combined with ample, excellent and good constituting one category and adequate, fair and poor in the other. Teacher training information was gathered in terms of five categories; M.A. in chemistry, college degree in chemistry, college graduate but not chemistry major, not college graduate, and training unspecified. In the analysis, training was considered qualified if the teacher had a college degree or Master's in chemistry. Teachers without either were placed in the unqualified group. Information on mental ability of students was obtained from three types of tests, the California Test of Mental Maturity, and I.Q. test, and a test of reading ability. In some schools where mental ability tests had not been given, the California test was administered. Some schools had information on file with one type of test while others had used another.

Again it was necessary to group students into two classifications for purposes of analysis with the students scoring above the average classified as high and those below as low. Obviously such gross classes obscured some of the relationships which might have been revealed with more precise classes. The conditions under which television was viewed were also observed during the visits to the high schools. Since it was impossible for the principal investigator to be present throughout the year, the statements of the teachers relative to their use of the television course had to serve as the basis for classifying a given school as a user or non-user. Subsequent investigation of the schools after completion of the observation period produced evidence that some schools were much more regular in their use of television than others which were included in the sample of television using schools. Considering the difficulties described above, the

homogeneity of the two samples of schools is certainly open to question.

The Anderson Chemistry Tests, Am and Bm, published by World Book Company, were used as standardized tests to measure achievement of chemistry students. Responsibility for administering these tests was given to the classroom teacher. Some were given at the end of the first semester, some at the beginning of the second semester, and some at the conclusion of the second semester. Insufficient cases were available to test the relative improvement in the students throughout the year. Grading and tabulation of the test results were completed by the principal investigator after the tests were returned to the University.

Information obtained from the schools, students, and teachers was coded and punched on I.B.M. cards with a separate card punched for each student. Tabulation and testing for significance was accomplished in the University Testing Service under the direction of Dr. Eugene Dutton.

RESULTS

In an effort to determine the influence of each variable under consideration in this research project, student cards were initially sorted according to race and teacher qualification. The significance of differences between students with qualified teachers and those without qualified teachers were tested by use of "t" tests. The results indicated that white students with qualified teachers achieved scores on both laboratory tests and total achievement significantly higher than students with unqualified teachers. Negro students did not differ significantly in performance on either test as indicated in Table II. Comparison of scores achieved by students with good and poor laboratory facilities and controlling race produced similar results. White students studying with good laboratory facilities exceeded the performance of those with poor laboratory facilities. However, the differences between Negro students was not statistically significant, except in the achievements of students on the laboratory tests. Laboratory facilities and qualified teachers would appear to be related to the achievement of white students, but the evidence is inconclusive with respect to their Negro counterparts.

Controlling race, sexual differences were measured and white males obtained significantly higher scores than white females. This relationship held true for tests of laboratory problems as well as general knowledge tests. Negro females achieved higher average scores than Negro males on both tests, but these differences were not statistically significant. Similar relationships were found in comparisons of achievements of both Negro and

white students classified by mental ability scores with differences significant among white students but not significant among Negro students. Significant differences for both Negro and white students, however, were obtained when comparisons were made between groups classified according to reading ability. In both instances the students with higher reading ability scored significantly higher than their racial counterparts with lower reading ability.

When comparisons were made between those students utilizing educational television and those without this medium, some curious results were obtained. Comparison of white students indicated that those utilizing television scored significantly lower on the achievement tests than those being taught without benefit of television. This finding held true on both the laboratory tests and the total knowledge tests for the white students. Similar comparisons among the Negro students revealed that television students achieved significantly higher scores on both types of tests than did those not using television.

The above results become explicible when reference is made to the characteristics of the samples as revealed in Table I. Seventy-one per cent of the total sample of white students not using television scored above average in mental ability. This compared with only fifty-five per cent of those using television. The television users were further hampered by the fact that sixty-three per cent of the females scored below average in contrast with only twenty-six per cent of the females in classes without benefit of television. Again, three of the white schools not utilizing television enjoyed the services of qualified teachers and good laboratory facilities in contrast with only one similar situation for the schools using television. These facts could easily account for the negative results among the white students using the television course.

The results among the Negro students become even less conclusive when Table I is examined. None of the students from schools not using television scored above the average in mental ability whereas twenty-eight per cent of those utilizing television was so classified. These facts cast some doubt on the validity of the finding that television was beneficial among the Negro students. Inability to control the variables sufficiently makes conclusions highly tenuous.

In an effort to test relationships by statistical controls, groups of students who had benefit of television were selected and matched with groups not using television, holding constant race, sex, and mental abil.ty or reading ability. Table III presents the results of these comparisons under varying conditions of laboratory facilities and teacher qualifications. The first three rows of data represent comparable conditions of laboratory and teacher

TABLE II

COMPARISONS OF STUDENTS GROUPED ACCORDING TO SIMILARITY OF CHARACTERISTICS AND EDUCATIONAL SITUATIONS: RACE CONTROLLED

Educational Situation X	Educational Situation Y	Second Semester Laboratory Scores				Second Semester Total Scores		
		X-Y M Diff.	St. Dev. M. Diff.	t	df	X-Y M Diff.	St. Dev. M. Diff.	t
W, Q. Teacher	W, UQ. Teacher	.555	.1436	3.868**	535	.710	.1611	4.407**
N, Q. Teacher	N, UQ. Teacher	—.259	.2675	.968	97	.090	.2730	.329
W, G. Lab.	W, P. Lab.	1.004	.1796	5.590**	535	1.352	.1993	6.784**
N, G. Lab.	N, P. Lab.	.770	.3314	2.323*	97	.151	.2728	.554
W, Male	W, Female	.471	.1425	3.305**	535	.671	.1591	4.217**
N, Male	N, Female	—.372	.2660	1.398	97	—.151	.2728	.554
W, Abv. M.A.	W, Bel. M.A.	1.883	.2156	8.734**	171	2.122	.2454	8.647**
N, Abv. M.A.	N, Bel. M.A.	.099	.3544	.028	59	.785	.3809	2.061*
W, Abv. Reading	W, Bel. Reading	1.076	.1719	6.259**	255	.....	.....	.....
W, Abv. Reading	W, Bel. Reading	.....	.....	.....	219	1.342	.2340	5.735**
N, Abv. Reading	N, Bel. Reading	1.059	.3279	3.230**	53	1.655	.3583	4.619**
=								
W, ETV	W, Non-ETV	—.511	.1306	3.913**	572	.....	.....	.....
W, ETV	W, Non-ETV	.....	.....	.....	534	—.590	.1552	3.802**
N, ETV	N, Non-ETV	1.001	.3407	2.938**	97	.822	.3517	2.337*

Legend:

W—White School
N—Negro School
Q—Qualified
UQ—Unqualified
G—Good
P—Poor
Abv. M.A.—Above average mental ability
Bel. M.A.—Below average mental ability
Abv. Reading—Above average reading ability
Bel. Reading—Below average reading ability
ETV—Schools using television
Non-ETV—Schools not using television
**—Statistically significant at the 1% probability level
*—Statistically significant at the 5% probability level

qualifications. The students watching television scored significantly higher at the .05 probability level only in the case of the male group with below average mental ability. The next group of comparisons was made with the television groups being taught by less well qualified teachers than those not using television. As expected those students under well qualified teachers exceeded the achievements of those using television but taught by inferior teachers. The next group of six comparisons was made with teacher qualifications held constant, but the television groups were using inadequate laboratories. Again the non-television groups scored significantly higher than the television groups.

The last five comparisons present an odd contrast with the findings of the previous sections of this table. Here the television groups had the double handicap of inferior teachers and inadequate laboratories. The differences between them and the non-television groups were statistically significant in only one instance, that of the group with above average mental ability. This was only in terms of their achievements on the laboratory parts of the test. Three of the remaining four comparisons were in the expected direction while one reversed the relationship. Obviously, the value of television as a substitute for inferior teachers or laboratories has not been demonstrated by these results. Conversely, the conclusion that television has no value in the teaching of high school chemistry cannot be concluded due to the inadequate controls possible throughout this research.

Scores of white students being taught with good laboratory facilities and unqualified teachers are compared with television students of similar sex, mental ability, and reading ability in Table IV. In the first two comparisons the laboratory facilities and teacher qualifications are equal for the two groups and the non-television groups significantly exceed the television groups on laboratory tests at the .05 level of probability. This result is also found in the next group of four comparisons even when the television groups are being taught by superior teachers. In the last group of four comparisons, the television group is subjected to inferior laboratory conditions. The same type of teachers as the non-television students and the non-television groups again excel, but not to a degree which is statistically significant.

The results in this table suggest that television may be more useful as a substitute for inadequate laboratory facilities than for inadequate teachers. This suggestion derives from the finding that where the non-television students enjoyed better laboratory facilities than the television students but were taught by similarly prepared teachers, the television students obtained scores lower than the non-television students. However, these differences could be due to chance. These results were the only ones where

TABLE III

COMPARISONS OF WHITE STUDENTS USING TELEVISION WITH THOSE NOT USING TELEVISION: MATCHING SEX, AND MENTAL ABILITY OR READING ABILITY, CONTROL GROUP WITH GOOD LABORATORY AND QUALIFIED TEACHER

Control (W, G. Lab, Q. Teacher)			Experimental (W, same sex, M.A., & Read. as control)		Second Semester Laboratory Scores				Second Semester Total Scores		
Sex	MA	Read	Lab	Teacher	E-C M Diff	St. Dev. M Diff	t	df	E-C M Diff	St. Dev. M Diff	t
M	Abv		G	Q	— .150	.3599	.417	48	— .095	.3936	.024
M	Bel		G	Q	1.114	.4387	2.539*	15	.757	.4354	1.739
F	Abv		G	Q	.0			19	.200	.5292	.378
M		Abv	G	UQ	—2.450	.4159	5.891**	40	—2.800	.5435	5.152**
F		Bel	G	UQ	—1.633	.6151	2.655*	21	—1.678	.7363	2.279*
M	Abv		P	Q	—3.233	.6607	4.893**	31	—4.000	.8648	4.625**
M	Bel		P	Q	—1.225	.5339	2.294*	16	—1.975	.4400	4.489**
M		Bel	P	Q	—1.671	.4051	4.125**	32	—2.557	.4265	5.995**
F	Abv		P	Q	—2.000	.5782	3.459**	20	—2.610	.4385	5.952**
F	Bel		P	Q	— .747	.4425	1.688	18	— .969	.7114	1.362
F		Bel	P	Q	—1.300	.4165	3.121**	31	—2.011	.4749	4.195**
M	Abv		P	UQ	—1.261	.4514	2.794**	36	— .889	.5558	1.599
M	Bel		P	UQ	— .200	.5033	.397	18	— .300	.4534	.662
M		Bel	P	UQ	— .500	.4175	1.198	33	— .633	.3990	1.586
F	Bel		P	UQ	.014	.4655	.030	15	.042	.5869	.007
F		Bel	P	UQ	— .708	.5288	1.339	24	— .903	.5961	1.515

Legend:

Control—Schools not using television
Experimental—Schools using television
W—White
G—Good
P—Poor
Q—Qualified
UQ—Unqualified
M—Male
F—Female
Abv—Above average
Bel—Below average
MA—Mental ability
**—Significant at 1% probability level
* —Significant at 5% probability level

the television students achieved scores which were not significantly different from the non-television students in statistical comparisons. However, this conclusion might be more meaningful if the television groups being taught by better qualified teachers than the non-television users, but with inferior laboratories, had also achieved scores which were not significantly different statistically. This was not the case and the conclusion is open to serious question.

Similar analysis of the Negro sample (Table V) seemed to indicate that students utilizing television profited from the experience. In all cases the students exposed to television performed better on the tests than did those not having access to television. These differences were not statistically significant except in two cases of comparisons between scores on laboratory tests and one case of comparisons between total scores. When conditions of laboratory facilities and teacher training were matched for the two samples the television groups performed better than the non-television groups, but the differences were not statistically significant.

Negro students being taught by inferior teachers but using equally inadequate laboratory facilities seemed to profit substantially from the television lessons. In two of the three comparisons of laboratory scores these differences were significant and in favor of the television students while differences between the two samples on total scores were statistically significant in only one of the three comparisons. Reference to Table I, however, suggests that these differences may be explained by the differences in mental ability between the two Negro samples, since the television groups included a higher proportion of students with above average mental ability than was true of the non-television group. Certainly these conclusions must be interpreted with care in view of these possible inadequacies in the samples.

In so far as possible, white schools were matched in an effort to produce more homogeneous groups of students in the different comparative categories. Table VI exhibits the results of statistical comparisons under these conditions. The first comparisons are between schools with adequate laboratory facilities and qualified teachers with the students separated according to sex and ignoring differences in mental ability. Males in the non-television schools achieved better scores than males in the television schools but the difference was significant only in terms of total scores. Reference to table one indicates that sixty-four per cent of these students in the television using schools scored above average in mental ability as compared with seventy per cent of the males in the non-television schools. This difference in mental ability might account for the differences between the matched schools without reference to the use or non-use of television.

TABLE IV

COMPARISONS OF WHITE STUDENTS USING TELEVISION WITH THOSE NOT USING TELEVISION: MATCHING SEX, AND MENTAL ABILITY OR READING ABILITY, CONTROL GROUP WITH GOOD LABORATORY BUT UNQUALIFIED TEACHERS

Control (W, G. Lab, UQ Teacher)			Experimental (W, same sex, M.A. & Read. as control)		Second Semester Laboratory Scores				Second Semester Total Scores		
Sex	MA	Read	Lab.	Teacher	E-C M Diff	St. Dev. M Diff	t	df	E-C M Diff	St. Dev. M Diff	t
M		Abv	G	UQ	—1.361	.5229	2.603*	28	—1.445	.7370	1.961
F		Bel	G	UQ	—1.467	.6421	2.285*	9	—1.067	.9579	1.114
F											
M	Abv		P	Q	—2.904	.7011	4.142**	15	—3.923	.8741	4.488**
M	Bel		P	Q	—1.534	.5834	2.629*	17	—2.602	.4922	5.286**
M		Bel	P	Q	—1.446	.4654	3.107**	36	—2.607	.4335	6.014**
F		Bel	P	Q	—1.134	.5317	2.133*	19	—1.400	.6666	2.100*
M	Abv		P	UQ	— .932	.4884	1.908	20	— .812	.5308	1.530
M	Bel		P	UQ	— .509	.5429	.938	19	— .927	.4891	1.895
M		Bel	P	UQ	— .275	.4045	.680	37	— .683	.4082	1.673
F		Bel	P	UQ	— .542	.6274	.864	12	— .292	.7825	.373

Legend:

Control—Schools not using television
Experimental—Schools using television
W—White
G—Good
P—Poor
Q—Qualified
UQ—Unqualified
M—Male
F—Female
Abv—Above average
Bel—Below average
MA—Mental ability
**—Significant at 1% probability level
* —Significant at 5% probability level

In the case of the female students from matched schools, the television students exceeded the non-television students on the laboratory sections of the tests, but the reverse was true for the total scores. Neither difference was statistically significant. It is interesting to note that seventy-four per cent of the non-television female students scored above average in mental ability while only thirty-seven per cent of the television female students achieved similar scores. In view of this fact, it is interesting to speculate about the results of this comparison had the two groups been more nearly alike in mental ability. In this case it might be suggested that the television female students would have achieved much higher scores than the non-television students.

The next group of comparisons in Table VI consists of television groups with inadequate laboratory facilities but qualified teachers in contrast with non-television groups with both adequate laboratory facilities and qualified teachers. In these comparisons sex, mental ability and reading ability are controlled. These results suggest that television is not an appropriate substitute for inadequate teachers since the non-television students with better laboratory facilities achieve statistically significant higher scores on the laboratory tests in five of the nine comparisons and eight of the nine comparisons on total scores. This conclusion becomes more plausible when the next six comparisons are reviewed and the non-television users are likewise studying with inadequate laboratory facilities. The differences are still in favor of the non-television users but they are statistically significant in only one case.

The last group of six comparisons shows the non-television users with good laboratories but inferior teachers and the television users handicapped with both poor laboratories and inferior teachers. Again the advantage of good laboratory facilities is demonstrated by the fact that the non-television users score significantly better on the laboratory sections of the test in four of the six cases but do not differ significantly on the total scores. These results suggest that television lessons may be a more adequate substitute for teachers than for laboratory facilities. This may be true particularly in terms of achievements on laboratory sections of tests since the television students do not differ significantly from the non-users in the case of total scores, but they do in the laboratory tests.

Table VII reveals data which further tends to substantiate the value of adequate laboratory facilities for the learning of chemistry in high school. When all white students not using television are compared with all white students having access to television but equipped with inadequate laboratories, the students not using television score significantly higher on both the laboratory sections of the tests and the total scores. However,

TABLE V

COMPARISONS OF NEGRO STUDENTS USING TELEVISION WITH THOSE NOT USING TELEVISION: MATCHED SEX AND MENTAL ABILITY OR READING ABILITY, CONTROL GROUP WITH INADEQUATE LABORATORY BUT QUALIFIED TEACHERS

Control (N, P Lab, Q Teacher)			Experimental (N, same sex, MA, & Read. as control)		Second Semester Laboratory Scores				Second Semester Total Scores		
Sex	MA	Read	Lab.	Teacher	E-C M Diff	St. Dev. M Diff	t	df	E-C M Diff	St. Dev. M Diff	t
F	all		P	Q	.658	.4624	1.423	21	.436	.2938	1.484
M & F	all		P	Q	.588	.3887	1.513	32	.294	.3108	.946
F		Bel	P	Q	1.056	.7695	1.372	9	.556	.5354	1.038
M & F	all		P	UQ	.968	.3917	2.471*	61	.633	.3640	1.739
F	all		P	UQ	1.475	.4749	3.106**	35	1.171	.4258	2.750**
F		Bel	P	UQ	.556	.5111	1.088	13	.223	.4016	.555

Legend:

Control—Schools not using television
Experimental—Schools using television
N—Negro
G—Good
P—Poor
Q—Qualified
UQ—Unqualified
M—Male
F—Female
M & F—Male and Female combined
All—All cases
Bel—Below average
**—Significant at 1% probability level
* —Significant at 5% probability level

when the same group of non-television users are compared with the group of students using television and having good laboratory facilities the results are reversed but not statistically significant. In this latter case the television students perform better than the non-television students on both the laboratory tests and the total tests.

In addition to the statistical results presented above, comments by teachers and observations by the principal investigator suggested further explanations for the inconclusive evidence reported. Good viewing rooms for the television lessons were the exception rather than the rule, however, audibility and reception were good in all cases. Only two groups of students using television had the advantage of having teachers who followed the suggested procedures in the television lesson outlines. Some teachers using television for only part of their sections were utilizing the suggestions contained in the television series in their non-television viewing classes. One teacher with multiple sections of chemistry used the television course for that section containing students with lower IQs and these students did as well as the other sections on the test given at the end of the school year. Several pieces of special type demonstration apparatus were constructed by students in several schools as a result of viewing the television lessons. These observations suggest that the experimental conditions were not fulfilled and a true test of the value of television in teaching high school chemistry was not obtained.

One teacher, who arranged to schedule all four sections in chemistry as television classes, stated that the lessons stimulated both his classes and his own work. He had been using television for the past three years and said there was a noticeable increase in the number of students from his school enrolling in scientific and related fields when attending college. First time users of the chemistry television lessons were less enthusiastic concerning the value of television than were those who had used it before. One first time user noted that as the course progressed more students were working on their own as a result of having seen the television lessons.

TABLE VI

COMPARISONS OF WHITE STUDENTS USING TELEVISION WITH THOSE NOT USING TELEVISION: MATCHED SCHOOLS

Control			Experimental		Second Semester Laboratory Scores				Second Semester Total Scores		
Sex	MA	Read	Lab.	Teacher	E-C M Diff	St. Dev. M Diff	t	df	E-C M Diff	St. Dev. M Diff	t
(G. Lab, Q. Teacher											
M	all		G	Q	— .011	.7515	.015	122	—2.538	1.1909	2.131*
F	all		G	Q	1.233	.8772	1.406	72	—1.076	1.5382	.700
M&F	all		P	Q	—1.378	.2945	4.679**	71	—1.794	.3438	5.218**
M	all		P	Q	—1.568	.4068	3.854**	37	—1.968	.4920	4.000**
M	Abv		P	Q	—2.295	.6774	3.388**	13	—2.818	.9112	3.093**
M	Bel		P	Q	—1.125	.5957	1.889	14	—2.000	.4954	4.037**
M		Bel	P	Q	—1.015	.4724	2.149*	21	—1.968	.4989	3.945**
F	all		P	Q	—1.139	.4346	2.621*	32	—1.569	.4864	3.226**
F	Abv		P	Q	—1.500	.7036	2.132	13	—3.547	.5690	3.547**
F	Bel		P	Q	— .636	.4585	1.387	17	—1.447	.6985	1.447
		Bel	P	Q	— .610	.4864	1.254	20	—1.304	.6024	2.165*
(P. Lab, Q. Teacher)											
M&F	all		P	Q	— .485	.3396	1.428	63	— .476	.3878	1.227
M	all		P	Q	— .753	.4720	1.595	30	— .753	.6357	1.183
M	Abv		P	Q	—2.036	.7306	2.787*	9	—2.429	1.0164	2.390*
M	Bel		P	Q	— .025	.6214	.040	11	— .075	.6804	.011
F	Abv		P	Q	— .500	.4850	1.031	15	— .443	.3208	1.381
F	Bel		P	Q	.764	.7025	1.088	14	.564	.8570	.658
(G. Lab, UQ Teacher)											
M&F	all	P	P	UQ	—1.289	.3844	3.353**	42	— .830	.4486	1.850
M	all		P	UQ	—1.301	.4970	2.618*	28	— .579	.5677	1.020
M&F	Abv		P	UQ	—1.000	.5660	1.767	16	— .333	.6786	.491
M&F		Bel	P	UQ	—1.165	.4510	2.583*	31	— .574	.4591	1.250
M	Abv		P	UQ	—1.578	.6901	2.286*	12	— .889	.8036	1.106
M		Bel	P	UQ	—1.233	.6102	2.021	19	— .266	.5664	.470

Legend: Same as other tables

TABLE VII

COMPARISONS OF WHITE STUDENTS USING TELEVISION WITH THOSE NOT USING TELEVISION: TELEVISION USERS WITH VARIATIONS IN LABORATORY FACILITIES

Control	Experimental	Second Semester Laboratory Scores E-C M Diff	St. Dev. M Diff	t	df	Second Semester Total Scores E-C M Diff	St. Dev. M Diff	t
All students, all conditions	All students with poor labs.	—1.199	.1925	6.299**	302	—1.541	.2300	6.700**
All students, all conditions	All students with good labs.	.199	.1616	1.231	304	.241	.1841	1.309

SUMMARY AND CONCLUSIONS

This research effort attempted to provide definitive answers to the question of the effectiveness of television instruction in high school chemistry under varied conditions. A sample of four white schools and four Negro schools using television, and six white schools and one Negro school not using television was obtained. Gross qualitative judgments of the adequacy of laboratory facilities, the quality of teachers, and broad classes of students' mental ability were utilized as controls. The schools using television were compared with those not using television by using student scores on a standardized chemistry test. All cells of the experimental design were not filled. Some cells contained more than one school, making it impossible to obtain conclusive results from these data.

Statistically significant differences were obtained between scores of white students working with good teachers in comparison with those working with less qualified teachers; between those with good laboratories compared with those with inadequate laboratories; between male students and female students; between those with above average mental ability compared with those with below average mental ability; between those with above average reading ability and those with below average reading ability; and between those not using television and those using the television lessons. Comparisons between Negro students were statistically significant only in the case of the good versus poor laboratory facilities, above average mental ability compared with those below average, and in the case of those with above average reading ability compared with those below average. Negro students utilizing the television lessons achieved significantly higher scores than their counterparts without benefit of television, but the reverse was found in the case of the white students as stated above.

Utilizing statistical controls in matching groups of students, various groups with similar characteristics were singled out and comparisons made between television users and non-users. When the quality of laboratory facilities and teacher training were high in both groups, students with high mental ability performed better without the use of television while students with below average mental ability performed better if they had the advantage of television lessons. When both television users and non-users enjoyed good laboratory facilities but less well qualified

teachers, the advantage seemed to rest with the non-television using students.

When comparisons between Negro television and non-television users were made under conditions of poor laboratory conditions but good teachers, the television students seemed to have the advantage. These results present a confused picture of the effectiveness of television as a substitute for either adequate laboratories or good teachers. It would appear that results were inconclusive probably because of the inadequacy of the sample size, inability to obtain adequate controls which would permit comparison of students using television with those not using it and vary only one factor at a time, and due to the gross measures used to measure variables.

Future research should be conducted with larger samples in order to provide the researcher with sufficient cases for adequate matching. The measures used to determine variations in laboratory facilities, teacher preparation, and mental ability should be sufficiently precise to permit more adequate classification of students. The gross measures used in this study probably concealed the variations to such an extent that their significance was obscured. As a result of the difficulties encountered in this project, it is suggested that better control be used in the case of the television users in order to insure that differences in performance of students can be assigned to either the influence of television or to other factors. Unless the teachers of chemistry courses are sufficiently familiar with the necessity for completely controlled conditions and are willing to cooperate completely, the research results will be contaminated by extraneous factors.